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California Test 749
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METHOD FOR DETERMING THE PERCOLATION RATE OF SOILS USING A 12-INCH-DIAMETER-TEST HOLE

A. SCOPE

The percolation test is a method of measuring the rate at which water will infiltrate or seep into a soil stratum under specific conditions followed throughout the test. By allowing water, placed in a carefully prepared hole, to percolate, time measurements of the drop in the water level are taken and an equivalent unlined 12-inch diameter percolation rate, expressed in minutes per inch, may be calculated.

Percolation test results, along with other considerations, may be used to determine the acceptability of soils for onsite wastewater disposal and for the design sizing of infiltrative surface areas, such as drainage basins.

The 12-inch-diameter-percolation-test method is the preferred method, however, the 6-inch-diameter-test method (Calif. Test 750) can be used in cases where site location limits the use of a backhoe or where 6-inch-diameter equipment is currently in use.

This method may involve hazardous materials, operations and equipment. This method does not purport to address all the hazards associated with its use. It is the responsibility of whomever uses this method to consult and establish appropriate safe and healthy practices and determine the applicability of regulatory limitations. Users of this method do so at their own risk.

B. APPARATUS

1. Digging apparatus (post hole digger, shovel, pick, etc.).
2. Perforated plastic pipe: 10-inch outside diameter with $\frac{3}{16}$-inch perforations placed at 4.9-inch horizontal and 2-inch vertical spacings, 12 inches in length, one per hole (Figure 1).
3. Automatic float valve, one per hole (Figure 2).
4. Garden hoses with "Y" connectors.
5. Stopwatch
6. Soil sample sacks
7. Backhoe

C. MATERIALS

1. Pea gravel or equivalent, approximately 0.5 cubic foot per hole.
2. Water (quantity depends on soil type).

D. PERCOLATION TEST PROCEDURE

1. Inspection of Soil: Visual classification of the soil in the area of the proposed leach field is advised. A series of soil profile trenches, approximately 8 to 10 feet deep, should be dug with a backhoe throughout the testing area to ensure that an accurate classification and thickness of each soil layer is obtained[1]. However, if soil borings of the area have been conducted and if the soil types and thicknesses are known, soil profile trenches may not be necessary.

2. Preparation of Test Holes: With the soil visually classified, a judgment as to the most suitable testing depth(s) can be made. Once this depth has been determined and site conditions permit, a minimum of three testing pits spaced throughout the testing area must be dug. Each pit, approximately 15 feet long by 5 feet wide, may be dug with the use of a backhoe, but only to within 12 inches of the final testing depth.

Two 12-inch diameter percolation test holes are then hand-dug the final 12 inches in each of these pits[2]. Using a post hole digger, shovel, etc., initially form the holes. Then use a small hand shovel or trowel to break loose chunks of soil and remove any shiny or smeared soil from the sidewalls and bottom. Remove the loose soil from the bottom of the holes without contacting the prepared sidewalls.

Care must be exerised while preparing the percolation test holes to ensure that the percolation rate obtained will be representative of the percolation rate of the undisturbed soil.

Retain a representative soil sample from the final foot of each test hole and conduct sieve and mechanical analyses of the samples (Calif. Tests 202 and 203). The results will be useful in verifying the visual classification of the soil and interpreting the percolation rates obtained for the design of the leach field network or other drainage facilities.

A 2-inch depth of pea gravel is then placed on the bottom of each hole. The perforated pipe is centered

[1] It is not necessary to enter the trench; obtain samples from the backhoe and use a measuring tape to obtain the thicknesses.

[2] Attempt to dig the hole exactly 12 inches in diameter; if, however, a larger hole is dug due to the presence of rocks, etc., obtain the actual diameter and use in the correction and conversion factors (See Sections E-2 and E-3).

in the hole and additional pea gravel is used to backfill around the outside. A sample of the pea gravel must be retained so that the porosity (n) can be determined for use in the correction factor calculation (See Section E-1).

3. Presoaking the Test Holes: Presoak each hole to its testing depth (8 inches above the bottom of the hole or 6 inches above the top of the gravel) for a minimum of 18 hours to obtain soil saturation and to allow for the swelling of any expansive clay which might be present in the soil. The use of automatic float valves to maintain the proper water level is preferable; if, however, they are unavailable, other methods must be used to ensure adequate presoaking.

Depending upon the source of the water, "Y" connectors may be used on the hoses to be assured of an adequate supply of water to each test hole.

4. Measuring a Stablized Percolation Rate: After the presoaking period, remove the automatic float valve, if used, and adjust the water depth to exactly 8 inches above the bottom of the hole (6 inches of water above the top of the gravel). With a stopwatch, measure the time required for the water level in each test hole to drop one inch. Immediately refill the hole to the 8-inch depth and retest.

If the time required for a one-inch drop is greater than 60 minutes, record the time required for a one-half inch drop in the water level, then refill to the 8-inch depth and retest.

A minimum of 6 readings shall be taken for each test hole. If the results of the last 3 readings vary by more than 5%, continue the test until the last 3 readings are within the limits. If, however, an extremely slow percolation rate is observed, conduct as many tests as possible within a 6-hour time limit.

All readings shall be reported in minutes per inch.

The average percolation rate for each test hole is calculated by taking the average of the final 3 readings. If only one or two readings were obtained per hole, due to a slow percolation rate, take the average of the readings and report this value as the average percolation rate.

Care must be exercised when water is added to the test holes. Be careful not to allow any material (i.e. loose soil, leaves, etc.) to fall into the holes, as this will lead to an error in the results.

An example of four different percolation test readings is shown in Figure 3.

E. CALCULATIONS

The average percolation rate obtained needs to be adjusted for the presence of the pea gravel and the perforated pipe and actual hole diameter.

The procedure and equations for these adjustments are as follows:

1. Determine the porosity (n) of the pea gravel. Fill a container of known volume with the pea gravel sample. The gravel should be poured into the container; do not shake or compact the gravel. Add water, and record the quantity necessary to fill the container. The porosity is equal to the quantity of water required to fill the container divided by the volume of the empty container:

n = Volume of voids/Total volume

2. Calculate the correction factor (C), to correct for the presence of the perforated pipe and pea gravel by the following equation:

$$C = n\left[1 - \left(\frac{O}{D}\right)^2\right] + \left(\frac{I}{D}\right)^2 \qquad \text{(See Figure 4)}$$

where D = Actual diameter of percolation test hole in inches
I = Inside diameter of perforated pipe in inches
O = Outside diameter of perforated pipe in inches
n = Porosity

3. Determine the conversion factor (K) to convert the percolation test hole diameter used to an equivalent 12-inch diameter hole:

$$K = 0.27 + \frac{8.70}{D}$$

4. The equivalent unlined 12-inch-diameter percolation rate (P) is calculated using the following equation:

$$P = \frac{(K)\ \ (R)}{C}$$

where R = Average percolation rate

F. SAMPLE CALCULATIONS

An average percolation rate of 2.9 min/in was obtained from a percolation test using the 12-inch-diameter test hole. The actual diameter of the test hole was found to be 12.5 inches. The inside and outside diameters of the perforated pipe were 9.8 and 10.1 inches respectively. The porosity of the pea gravel used was found to be n = 0.37.

What is the equivalent unlined 12-inch diameter percolation rate?

Correction Factor Calculation

$$C = n\left[1 - \left(\frac{O}{D}\right)^2\right] + \left(\frac{I}{D}\right)^2$$

$$= 0.37 \left[1 - \left(\frac{10.1 \text{ in}}{12.5 \text{ in}}\right)^2\right] + \left(\frac{9.8 \text{ in}}{12.5 \text{ in}}\right)^2$$

$$= 0.74$$

Conversion Factor Calculation

$$K = 0.27 + \frac{8.7}{D}$$

$$= 0.27 + \frac{8.7}{12.5}$$

$$= 0.97$$

Note: If test hole diameter is 12.0 inches, K = 1.0

Equivalent Unlined 12-inch Diameter Percolation Rate

$$P = \frac{(K)\ (R)}{C}$$

$$= \frac{(0.97)\ (2.9 \text{ min/in})}{0.74}$$

$$= \underline{3.8 \text{ min/in}}$$

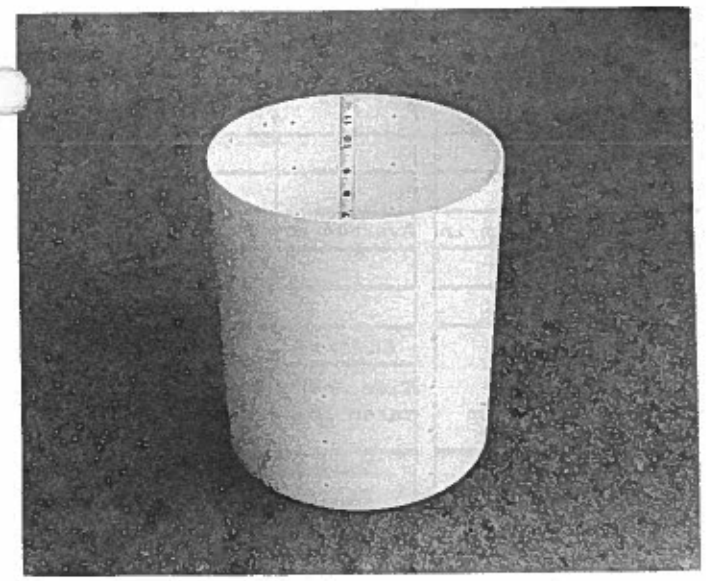


FIGURE 1

Perforated Plastic Pipe

FIGURE 2

Automatic Float Valve

PERCOLATION TEST

TRANSPORTATION LABORATORY

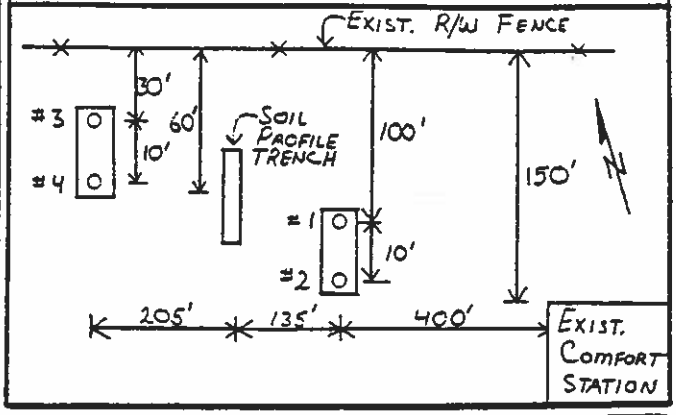
LOCATION	Smalltown CA
DATE	6-24-83
TEST MADE BY	DS/MN
AMBIENT TEMPERATURE	72 F
WEATHER COND.	Clear
SOAKING PERIOD	19 hours
TYPE OF SOIL	Sand-Clay

$$\text{Conversion Factor} = .97 \div \frac{hd^2}{D^2}$$

$$\text{Correction Factor} = \left[1 - \left(\frac{d}{D}\right)^2\right] \div \left(\frac{i}{D}\right)^2$$

n = 0.37

No Scale — SITE LAYOUT



HOLE NO.	1
HOLE DEPTH	4.5'
HOLE DIA.	12.5in

TIME	READING
2min45sec	8" - 7"
2min50sec	8" - 7"
2min58sec	8" - 7"
3min10sec	8" - 7"
2min55sec	8" - 7"
2min53sec	8" - 7"
2min54sec	8" - 7"
Ave(last3)	=2.9min/in

REMARKS: Time measurements taken for a 1" drop

CONVERSION FACTOR (K)	.97
CORRECTION FACTOR (C)	.74

PERC. RATE CALC.

$$p = \frac{K \cdot R}{C} = \frac{(.97)\left(2.9 \frac{min}{in}\right)}{.74} = 3.8$$

PERCOLATION RATE	3.8 min/in

HOLE NO.	2
HOLE DEPTH	4.5'
HOLE DIA.	12.0"

TIME	READING
53min15sec	8" - 7"
50min45sec	8" - 7"
51min30sec	8" - 7"
53min00sec	8" - 7"
54min30sec	8" - 7"
52min00sec	8" - 7"
Ave(last3)	=53.2min/in

REMARKS: Time measurements taken for a 1" drop

CONVERSION FACTOR (K)	1.0
CORRECTION FACTOR (C)	.78

PERC. RATE CALC.

$$p = \frac{K \cdot R}{C} \quad \frac{(1.0)\left(53.2 \frac{min}{in}\right)}{.78} = 68.2 \text{ min/in}$$

PERCOLATION RATE	68.2 min/in

HOLE NO.	3
HOLE DEPTH	4.0'
HOLE DIA.	12.0"

TIME	READING
45min30sec	8" - 7½"
47min15sec	8" - 7½"
46min15sec	8" - 7½"
46min30sec	8" - 7½"
43min15sec	8" - 7½"
44min45sec	8" - 7½"
Ave(last3)	=89.7min/in

REMARKS: Time measurements taken for a ½" drop

CONVERSION FACTOR (K)	1.0
CORRECTION FACTOR (C)	.78

PERC. RATE CALC.

$$P = \frac{(1.0)\left(89.7 \frac{min}{in}\right)}{.78} = 115 \text{ min/in}$$

PERCOLATION RATE	115 min/in

HOLE NO.	4
HOLE DEPTH	4.0'
HOLE DIA.	13.0"

TIME	READING
154 min	8"- 7½"
159 min	8"- 7½"
Average =	313min/in

REMARKS: Time measurements taken for a ½"drop

CONVERSION FACTOR (K)	0.94
CORRECTION FACTOR (C)	0.72

PERC. RATE CALC.

$$P = \frac{(.94)(313 \text{ min/in})}{.72} = 409 \text{ min/in}$$

PERCOLATION RATE	409 min/in

TL-3163 (REV 1/85)

EXAMPLE OF PERCOLATION TEST DATA

FIGURE 3

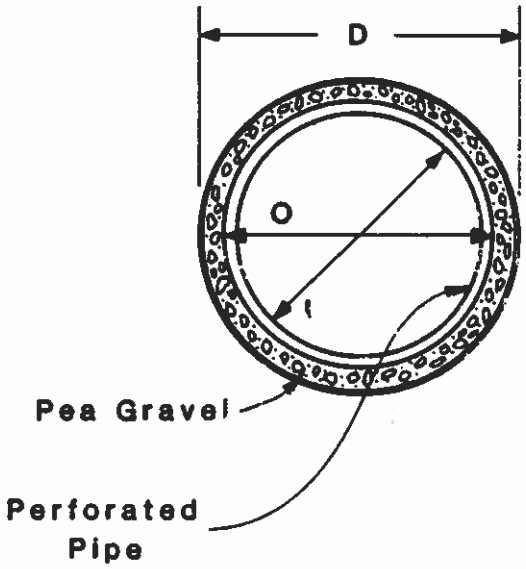


FIGURE 4

Dimensions of Test Hole and Perforated Pipe

Reference: Van Kirk, J. L., W.A. Grottkau, R. B. Howell and E. C. Shirley, "Percolation Testing for Septic Tank Leach Fields At Roadside Rests", FHWA/CA/TL/81/05 1981